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PSYCHIC RESEARCH IN THE ANIMAL FIELD: DER KLUGE HANS AND THE ELBERFELD HORSES

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The story which I have to tell has to do in the first instance with the mental powers and behavior of horses, but in the end throws an interesting cross light on the mental and bodily behavior of man, and promises in its further development to illuminate some of the darkest corners of human psychology.

Ten or twelve years ago there appeared in a couple of German papers, one military and one civilian, a small advertisement offering for sale a seven-year-old stallion who could distinguish ten colors and knew the four rules of arithmetic. Practically nothing came of it; the advertisement was lost in the flood of general advertising. Again after an interval of more than a year there appeared in the same way a still smaller advertisement inviting readers of the papers to visit, free, certain experiments then in progress for determining the mental powers of horses. This time the arrow found a mark. The advertisement, by good luck, fell under the eyes of a retired Brigadier General of the German army, Zobel by name, an acknowledged expert in matters pertaining to horses. General Zobel visited the address given, saw what the horse could do, and in course of time published in the supplement of one of the Berlin daily papers an account of what he had seen, thus bringing *der kluge Hans* and his master for the first time to public notice. The general's name and fame caught public attention and sent others to see the wonderful horse for themselves and they in turn interested still others, until the thing became a

veritable midsummer sensation. Discussion followed in the newspapers of Berlin and other German cities and echoes of it penetrated into Italy and America.

There were not a few skeptics, of course, who thought the thing was a fraud, that the horse was merely manipulated in some clever way by his master. But there were circumstances which spoke against this. It was hard to find any reason for the fraud and though some men like to gull their neighbors, they do not do it for long together without some purpose in doing it, and here a motive seemed lacking. There was no money feature connected with the exhibitions and no attempt of the master to exploit himself or the horse. He refused altogether to exhibit upon the vaudeville stage. And still more to the point—the horse solved problems for others beside his master, some of them men whose good faith could not be called in question. And finally a group of well-known gentlemen, including army officers, experts in horse matters and animal training, teachers, men of affairs and scientists, who had gathered as a voluntary investigating committee, studied the performances carefully and reported unanimously that they had been unable to discover anything whatever in the nature of fraud, that no intentional signals were used, and that so far as they had been able to discover there were not even any unintentional signals of any known sort. This last the general public took to be equivalent to an assertion of the committee's belief that the horse actually did on his own account the things that he was reported to do. This of course served only to whet public interest still further. Conjectural explanations were many but nothing like a final solution appeared, until a small group of experts took the matter in hand, and after a couple of months brought forward an explanation which was generally accepted as the final verdict of science and brought discussion to an end.

This is the outline of the first chapter of our story; let us come to the details of it. Let us imagine that we have obtained an invitation to one of the exhibitions, for they are semi-private, and are to see the thing for ourselves like the other Berliners. We take our way to the northern portion of the city and reach finally, in a rather poor district, a paved court, none too clean, surrounded by high tenement houses. In this court often before very distinguished company—besides uninvited guests in the tenement house windows and boys on the roofs and fences—the remarkable things take place.

The horse is a black stallion of Orloff trotting stock about eight years old and his master is Herr von Osten, a retired Prussian schoolmaster, now past sixty years of age, and dressed usually in a long, seedy overcoat, or "duster," and slouch hat. There are no restrictions as to the place we may occupy. We may come as near as we choose and look on from any side. The horse is entirely free and is managed wholly by means of the voice with frequent rewards in the way of bread and carrots, for which he is eager, as he gets little exercise and is therefore on short rations. He is spoken to in German, but without special emphasis. If he understands a question, he signifies it, we are told, by nodding his head; if he does not understand, he moves his head from side to side. By head movements also he indicates directions: up, down, right, left. We are warned that he will not reply to questions addressed to him in French or Latin and that he does not understand all German words, though he appears to comprehend a great variety of questions, or at any rate answers correctly, and his vocabulary seems to increase daily.

His powers of communication are, however, decidedly limited; he moves his head, he can go here and there and do this or that, and finally he can indicate numbers by tapping or pawing with his fore foot; and in this way the answers to questions are generally given, his master having devised special means by which answers can be indicated by appropriate numbers.

When the exhibition begins, this is the sort of thing that we witness. His master, standing near him, addresses him in a kindly way and shows him an arrow, a circle and a square drawn on three little blackboards hung up conveniently and asks him to pick out the arrow. Hans goes to the proper board. In the same way he tells which is the square and which the circle. Herr von Osten then asks, "How many corners has a circle?" to which Hans very properly replies by moving his head from side to side; there are no corners. Next several gentlemen are placed in a row and Hans indicates correctly, by tapping off the proper place number, which is the tallest, which the stoutest, which are officers, which have swords, which has his arm in a sling.

These tests, which can be made in very great variety, seem to show that Hans can understand what is said to him; but the test with the row of gentlemen has really involved more than the mere comprehension of words; the horse has counted, and counting, if carried, say, beyond three, involves some-

thing like abstract thought. He will, moreover, count anything you like, or tap off any reasonable number, and seems to show intelligence in it too; for he executes small numbers slowly and large numbers quickly, raising his foot but little at first as though he had a long lot of tapping to do and wished to get through the unessential parts as quickly as possible. After giving the last tap he brings his foot back to its original position or sometimes finishes with a smart stamp with his left foot. For zero he moves his head from side to side.

Counting is an abstract process, to be sure, but a simple one, and his master goes on to ask other questions: How much is 4 times 4? Hans replies with the required 16 taps. How much is 4 and 4? Hans gives the necessary 8. In the same way he gives the answers to problems in division and subtraction. He is asked, for example, By what numbers is 28 divisible? And we get in series 2, 4, 7, 14, and 28 taps. Fractions are no bugbear to him. He will change common fractions into decimals or vice versa or work with either. "How much is $\frac{2}{5}$ and $\frac{1}{2}$?" his master asks, and Hans taps off 9 for the numerator and 10 for the denominator: 9/10. He usually works with numbers below 100, and when he deals with larger numbers, as is sometimes required, he is said to handle them by analogy with what he knows of the lower ones, showing in this way, if the statement is true, a very good grasp of the abstract plan of the number system.

When, as sometimes happens, he has given a wrong answer, it is usually only necessary to ask him "By how many have you miscounted?" to receive the appropriate correction. Sometimes, however, he seems cranky and having given a wrong answer will stick to it, and sometimes he seems only to want to joke with his questioner.

Now his master turns to reading and spelling. Certain words are written on the little blackboards—common words or the surnames of persons present,—and Hans will, when one or another is pronounced, indicate the serial number of the board on which it is written, or, if required, go to it and touch it with his nose. In a similar way when asked for the color of certain bits of colored cloth, he indicates the number of the board bearing the name of the color or goes to and touches the bit of cloth having the color named. He will even match colors on occasion or correct a false indication when his attention is called to it.

He spells by means of a chart on which the letters are written in tabular form so that each can be indicated by

the numbers of its row and column. Thus in reply to the question: "What has the lady in her hand?" he taps off the series 5-2, 3-2, 4-6, 3-7, which being interpreted spells *Schirm*, the German for sunshade, *sch* being treated in the tables as a single letter. He seems to remember well what he has spelled out in this way and will also spell out the surname of persons who have been introduced to him.

Now the master shows him a watch and asks him what time it is, and being told follows with questions like these: "Between what figures will the small hand be when the time is five minutes after half past seven?" or "Over how many minutes must the large hand move to get to the position of a quarter of the hour, when it starts at 7 minutes after a quarter past the hour?" to all of which he gets correct replies. But in other respects also Hans seems at times to show keen powers of observation. When asked, for example, how many fingers a certain gentleman of the company had on his right hand, he promptly and to the surprise of the spectators answered *four*, which examination proved to be correct.

And now his master tries him at indicating the value of German coins, the signification of playing cards, at giving the days of the week and of the month, the emperor's birthday, and the identification of people by their photographs, in all of which he succeeds as usual.

There is not much evidence that horses are very discriminating musically—rather the reverse—but Herr von Osten now proceeds to demonstrate in Hans a definite knowledge of music. He blows a tone upon a sort of small keyed harmonica, and asks Hans to tell the tone given, which he does by means of a chart upon which the notes are written in such a way that each can be indicated by a number. The master sounds a discord (*c*, *d* and *e*) and asks, "Does that sound well?" Hans moves his head from side to side. "What tone must be left out?" Hans stamps twice for the *d*. He answers correctly also when asked to name the various musical intervals used, both when the tones are sounded simultaneously and in succession—feats which in a human subject would deserve the name of fair musical talent.

Such things as these were not done of course in continuous succession, perhaps not all on the same day, and always with short intervals of rest and frequent rewards of something to eat. Nor did the exhibitions always run smoothly; Hans sometimes made mistakes and was sometimes intractable even in the hands of von Osten. Nevertheless in course of time things like those I have mentioned were done again

and again in the presence of all sorts of spectators and with all sorts of variations. They were done, in the absence of von Osten, by several gentlemen who were interested in the case, though usually with a greater proportion of failures, which might easily be due, it seemed, to unwillingness on the part of the horse or to unfamiliarity with a strange questioner.

One very remarkable, though perfectly authentic instance of Hans' performances, I have reserved until the last as it seems to show even super-normal powers. The following experiment was made a number of times by Herr Schillings, an African explorer and a man of scientific standing, who very early succeeded in getting Hans to answer questions for him. While Hans was standing in his stall, Schillings would approach, accompanied by a second gentleman. At Schillings' request this gentleman would think intently of a number between 1 and 20, but would keep it absolutely to himself. Schillings would ask Hans to tap off the number thought of, and then would withdraw as completely as possible from the performance, in other words, would remain absolutely passive. On several occasions Hans played his part as mind-reader with astounding success, tapping off correctly the number unspoken and absolutely unknown to Schillings.

Here then is our problem—how to account for the doings of a horse that to all appearances understands spoken and written words, knows the calendar and can tell time, can do the abstract thinking required in arithmetical work, and has besides very fair powers in music and other directions—who on *prima facie* evidence lacks, as his admirers asserted, nothing at all of the human mental outfit except the power of speech.

Of solutions there was no lack. The explanation of his master, von Osten, was the very simple one that the horse had the mental powers which he seemed to have—that he was able to think and as a matter of fact did think for himself and answer the questions put to him. Hans had a mind, and his mind was capable of education. What Hans was now able to do was the natural result of a thorough and careful course of education. He (von Osten) had spent four years of hard and patient labor in *educating* him, making use of the same pedagogical principles that are in use in the teaching of children. Compare an untaught child with a well-taught one. The difference is great, and such a difference is as natural in horses as in children. The result seems astonishing no doubt, but it is so simply because nobody has

ever before made a serious attempt to *educate* a horse. Nothing, in fact, irritated the old man more than the suggestion that Hans was merely a trained animal and not an educated one.

In this opinion, at least as far as that the horse could think for himself, von Osten was by no means alone and many of his supporters were men of distinction. Even Prof. Stumpf of the University of Berlin (who served on the original investigating committee and under whose general oversight the later studies were made) was beginning, as he himself confesses, to set his mental house in order for the acceptance of the notion that horses have some educable rudiments of abstract thought—provided such a conception should at last seem unavoidable.

Over against this explanation, however, stood the diametrically opposite view—the opinion that Hans was trained, and not educated; that his so-called answers were merely pieces of behavior associated by repetition with certain objective conditions which served as cues. When he names the tones which have been sounded in a given chord, he sees the keys of the instrument move and moves his foot as many times as he has been trained to move it under such circumstances, knowing nothing either of music or of counting. His numerical feats are not calculations at all, but mere matters of memory, suiting a certain amount of tapping to a certain sound of words. This demands an enormous power of general retention; but then, it was argued, the memory of the horse species has lain fallow for untold ages and we may therefore expect a phenomenal crop from it. This view of course depends upon strange notions of the nature of mind and is a great strain upon one's credulity, but nevertheless it had its supporters.

A third party would hear of neither a thinking horse nor of one with a long memory—though they were ready enough to accept the idea of signals of some sort. Indeed they rested their whole explanation on signals. Most of those who held this view had no hesitation in declaring that the horse was controlled by intentional signs given by von Osten—that the whole affair was nothing but clever circus trickery. And in this group were found in strange alliance those to whom for ulterior reasons (philosophical, theological or otherwise) the idea of a thinking horse was repugnant, those who rejected a thinking horse simply as opposed to common sense; and, lastly, most of the professional horse trainers who felt

that they knew the business of trained animals so perfectly that they might save themselves the trouble of examining this case, or who were satisfied with a very cursory examination.

A few of those who held to the explanation by signals thought the signals might possibly be unintentional, but they did not venture to specify in detail what sort of signals were in use, nor, with one possible exception, offer proof for their hypotheses.¹ Those, on the contrary, who believed in intentional signaling suggested a great many; the signals were somehow given by means of Herr von Osten's old gray slouch hat or by his long overcoat or with his hand as he reached into his pocket for carrots. Others said the signs were eye movements or movements of the hands or were given by changed intonation in asking the questions. But many observers, including the only experienced horse-expert who studied the case carefully, had failed to find that signs were used.

And then finally there were those who could not satisfy themselves at all with explanations of the ordinary sort and sought out extraordinary ones. Some suggested that the horse responded to radiant heat streaming out from the questioner, or to electric apparatus in the ground acting on the horse's hoof, or *n* rays emanating perhaps from the brain of Herr von Osten, or waves of thought proceeding from the same source, or magnetic or hypnotic influences, or last of all—and capable of everything—"suggestion!"

Taking all these together and neglecting small differences we have four rival hypotheses: 1) The horse can think for himself; 2) The horse cannot think, but has a phenomenal memory and is a marvel of training; 3) The horse has no need to think or even to remember, but is manipulated wholly by signals given by his master at the moment; and 4) The affair is occult and to be explained by the operation of powers and influences of which we know less than we do of horses.

With such a wealth of hypotheses it is clear that what is most needed is a careful sifting out of the facts, and, if possible, the testing of what seem to be facts by experiments carefully planned and methodically carried out. And these were fortunately forthcoming. A thorough study of the horse and his performances was begun by Prof. Stumpf and his assistants—one of whom, Dr. Oskar Pfungst, gave himself

¹ The exception was Cav. Emilio Rendich, an Italian painter resident in Berlin, whose part in this matter will be referred to later.

especially to it, and was able before long to let in a flood of light upon the mystery.²

Scientific method is simply systemized common sense, and the first step was, naturally, to find out whether or not the horse could think for himself by testing him with questions the answers to which were unknown to the questioner, or any one else present. Some tests of this sort had been made by the original investigating committee and had seemed to show that under such circumstances Hans could answer correctly. It was therefore essential first of all to put this matter to the most rigid possible test and confirm or demolish these supposed results. And to do so it was necessary to arrange the tests in such a way that the chances of purely accidental successes and failures might be estimated, in other words, to alternate questions in which the answer was known to the questioner with those in which it was not known. If under these circumstances Hans succeeded as well in one case as in the other, his ability to think would be fairly demonstrated; if he failed in the trials in which the questioner did not know the answers and succeeded in those in which the questioner did know the answers, his dependence upon the questioner would be as fairly demonstrated, and the discovery of the nature of the dependence would be the next problem to be undertaken.

Let us see what the results of such tests were like. The experiments were made in a tent set up in the courtyard where the exhibitions had taken place. A tent was used in order to shut out distractions and cut off the possibility of long distance signals. The questioner was usually, though not always, Dr. Pfungst, who had worked enough with Hans to have shown himself entirely competent. At times several persons were present, including Herr von Osten, but at other times also Dr. Pfungst worked alone.

Let us see whether Hans can read numbers. A set of figures printed or written on cards is shown to him one by one in such a way that he alone can see them, and he is directed to tap off the number shown. In approximately alternate cases the conditions are the same except that the number is known to those present, including the questioner. This test was tried in all 91 times (49 when the number was unknown to the

² The first authentic account of Pfungst's work was a brief report by Prof. Stumpf in December, 1904. Pfungst's own complete account appeared in German in 1907 and in English translation in 1911. The present account of the Hans case was drawn chiefly from Pfungst's original work.

questioner and 42 times when it was known). Hans was right 4 times in 49 when the number was unknown to the persons present; and he was wrong in only one case in 42 when the number was known to them. His four successes—less than one in ten—can hardly go down as more than lucky hits. And we may add that the result was not essentially different when von Osten himself acted as questioner instead of Pfungst. Such results throw Hans' ability to read figures on his own account into very serious doubt.

Similar experiments with words, written on the little blackboards and hung up in a row, which Hans was to "read" by tapping off the number of the board carrying the word called for, succeeded no better, though the words were such as Hans might be supposed to know, such words as *Hans*, *stall*, and the names of the colors. Out of 26 trials in 14 of which the words were known to the questioner and in 12 unknown, Hans never failed to tap off the right number in the first case and never succeeded in hitting the right number in the second case. His reading of words would seem to be of the same doubtful nature as his ability to read figures.

Let us see how he does with arithmetic; perhaps he can reckon better than he can read. A number is whispered to him by Herr von Osten and a second by Dr. Pfungst; Hans is to give the sum. This was tried 62 times, 31 in each condition as regards knowledge, or the lack of it, on the part of the questioner. When the questioner knew, Hans was right 29 times; when he did not know, Hans was right 3 times—again in less than 10% of the trials.

The story is the same when he was required to spell or to count: when the questioner knew, Hans was right; when the questioner did not know, Hans was all at sea. The case looks dubious for his ability to deal with numbers and for the assumption of powers of abstract thought based upon that ability. But let us try his memory and his stock of information. When asked to give the day of the week on which certain days of the month would fall when Sunday was the first, he failed in 10 trials out of 14, but succeeded in 4. This is a better record than any other so far, but even this we cannot allow to stand to his credit, for the answers to just these four questions were known to the hostler who was present during the experiments. Under similar careful experimentation his musical knowledge—both his recognition of the pitch of tones and their relation to one another—melted away. If the questioner knew, Hans knew; if the questioner did not know, Hans did not know.

Taking the tests all together, the evidence seems unmistakable. Hans does not think for himself, but has some way of drawing upon the information of his questioner or others in his presence. He clearly does not pass his examinations on the honor system.

The less systematic tests of the original investigating committee and those of others who at various times appeared to get different results, but with reference to whose care in observing the proper precautions there is doubt, cannot be given weight in the face of the uniformly contrary results here attained. It is easier to believe that in those cases some essential precaution was neglected than that any peculiarity in the procedure of Dr. Pfungst should have brought such regularly negative results as he and his colleagues found.

Our first question then—whether Hans thinks for himself in a human way—may be answered in the negative with practical certainty: He does not. But in answering it in this way we have rendered the case, if anything, more mysterious than before. Hans is dependent in some way on the information possessed by his questioner, but: How? We are face to face with our second question.

Does he get his information or his cue through some one of his five senses or in some less usual and perhaps occult way? Is it a matter of seeing, hearing, touching, tasting, smelling, or of thought transference? Naturally we try the senses first and begin to test him again when he is for the time prevented from using one or another of them; and, first of all, sight. Hans is therefore rigged out with large blinders which are so arranged as not to bother him at all in themselves but effectually to cut off his vision backward. The questioner now gives Hans numbers to tap off—first standing back where he cannot be seen and then again asking for the same number while standing forward where he can be seen.

I said the blinders were so arranged as not to bother the horse at all “in themselves,” but the experimental conditions as a whole evidently bothered him a good deal. He always tried hard to get sight of the questioner when the latter stood out of sight, backing up to do so, and when an attempt was made to tie him so as to prevent this, getting fractious and breaking his rope, though usually he made no objection to being tied. As a result of his efforts to get sight of the questioner, it was not possible to be sure in all cases whether the test was made with or without sight of the questioner. In 35 out of 102 trials he certainly did not see the questioner; he certainly did see him in 56 cases; and in 11 it was uncertain.

In the 35 cases without sight of the questioner Hans was successful but twice; in the 56 cases with sight of the questioner he was right 50 times; and in the 11 doubtful cases he was right again twice. The result is clear: when he saw, he succeeded; when he could not see, he failed. To get this result it was necessary, however, to look carefully to the size of the blinders and to their putting on. Experiments with less care in these respects gave a much larger proportion of successes.

Incidental observations also seemed confirmatory of the importance of vision. The horse was more apt, so far as one could tell, to look at his questioner than at the persons or things he was supposed to be counting or at the words he was supposed to be reading; and he was apt to get uncertain in his answers if experiments were continued into the twilight.

From these experiments and observations it seemed clear to Dr. Pfungst that Hans got his information through his eyes; but did he get it all that way; did he get any through hearing or his other senses? It seemed rather unlikely that he depended upon other senses than his eyes. As regards hearing it was discovered that he could answer correctly when the questioner made no sound whatever—merely *thought* the question and *thought* the answer; and further that the animal was not usually disturbed in his tapping by loud calls or commands provided they were unaccompanied by movements; and, finally, it was noticed that he rarely or never cocked his ears in the direction of the questioner, a thing that horses are very prone to do when listening for any particular sound.

At any rate no further tests of the senses were made by these investigators; and here, perhaps, in view of later developments, lies a serious incompleteness in their work. It was very natural, however, that they should not follow sense tests further at this time; for at about this stage of the work Dr. Pfungst was fortunate enough to discover in the case of Herr von Osten himself certain very slight, almost imperceptible movements of the head and body—movements often as small or smaller than one one-hundredth of an inch in extent, which seemed clearly to be the visible cues by which the horse was controlled. Later he traced such movements in others for whom Hans would answer questions, including himself, was able to point them out to other observers who could then see them without great difficulty, knowing what to look for, and finally to make them voluntarily and thus to draw from Hans any answer to any question, or no question at all.

When the questioner addressed a question to the horse he bent forward very slightly to see better the movement of the horse's foot. This forward inclination served as a starting signal and Hans began to tap. When the required number was reached, if the questioner knew it, he involuntarily raised his head ever so little again (as one might do when the need for the closest attention was past) and this served as a signal for the tapping to cease. Then the trial being over the questioner usually stood erect again, though this larger movement did not serve at all as a signal, except in a negative way. In case it did not follow promptly on the slight raising of the head (the true signal for cessation) a single additional tap with the left foot followed, after which, if one still remained bent, tapping with the right foot would be resumed. One might stand before Hans and ply him with questions as long as one pleased, but never an answer was forthcoming as long as one stood perfectly still and erect. The tapping began on the forward bending of the questioner and the tapping ceased when the slight upward movement of the head was given, and did not stop without it, though it appeared later that other somewhat similar movements of other members than the head might also serve. The rate of tapping was also found to vary with the amount of stooping on the part of the questioner. If the latter bent far forward Hans worked rapidly; if only a little, then more slowly; and there were many other confirmatory details.

Usually, as it seemed, the horse was attentive to the questioner alone, and stopped and started on signals from him only; but in the case of the days of the month he seems to have stopped at signals from the hostler, and the cases of apparent mind-reading above mentioned were undoubtedly of a similar sort. Herr Schillings started him tapping, the gentleman whose mind was read unwittingly stopped him. There was nothing else necessary.

Minute movements of a somewhat similar character are a common means of control in the management of trick horses. The point here is that the movements were extremely minute and that there seemed no reason to suppose they had been adopted consciously by those for whom the horse responded.*

* It would appear that the honor of the first observation of these minute unconscious movements of von Osten and others does not belong to Pfungst, though there is no question that the full demonstration of their importance is his. Cav. Emilio Rendich, already mentioned, after a period of belief in the independence of Hans' performances was later thrown into doubt on account of their in-

I have gone into some detail with these cases in which Hans answered by tapping because they are the most interesting and were the most fully studied, but it will be recalled that he answered certain questions by head movements—assent and negation by nodding and moving the head from side to side, and the directions up, down, right and left by corresponding movements. These, like the tapping movements, proved to be given in response to minute but appropriate head movements on the part of the questioner. Other answers were given by going to specified objects, to the colored cloths or the little blackboards, for example, and fetching them or touching them with his nose. In this he was guided by the position of the questioner who usually faced toward and looked directly at the object in question. In experiments of this kind Hans was not uniformly successful at any time, even when helped out by word of mouth. When the questioner called out to him "Wrong," or "Look out," or repeated the color name, he would give up the thing he was about to take and take another, but not by any means always the right one; and in this way—by calling out—his answers could be quite variously manipulated. In a word there was nothing in the experiments on these matters to invalidate the results of the studies of the tapping, and we may sum the whole thing up by saying that they seemed to Dr. Pfungst and his colleagues to put it beyond question that all of the answers which Hans gave were merely sets of movements controlled by signals from his questioner.

And so we have, as the result of these careful studies, a horse proved to be destitute of the human mental powers with which he had been credited, but demonstrated to be astonishingly responsive to almost imperceptible movements, and ready enough to make use of them and of the faculties of such a mind as he had for the sorts of results in which he as a horse was interested, namely, bread and carrots.

It may help us to understand his cleverness in catching these movements to recall that movements as such are seen by ourselves with some ease even in the remote parts of the visual field where we can see little else; that the attention of animals

creasingly extraordinary character and set out to find some other explanation. His search was rewarded by the discovery in von Osten and Schillings of slight movements which seemed to guide the horse in his tapping. Later Rendich trained his shepherd dog, Nora, to respond to similar movements and exhibited her to several members of the original Hans committee. His discovery antedates the work of Pfungst and his associates, and Pfungst is said to have seen the dog work, though it is not, of course, by any means certain that Rendich at the time explained his methods.

in general appears also to be caught very easily by movements; that there seems some reason to believe that the eyes of horses are unusually well adapted anatomically for the perception of movements; that the detection of small movements of their enemies would be of the greatest advantage to horses in their wild state; and that Hans himself had had a four years' course in perceiving those of Herr von Osten.

So much for the animal side of this remarkable case. The human side is no less important; how does that stand? Were the signals really unconscious in the case of Herr von Osten? Is it possible that he was absolutely ignorant of the movements by which for years he had been managing the horse? Or was he after all but an unusually clever trickster with a more than usual appetite for humbug. This last inference is one that is easy to draw and was drawn by many. What is the evidence pro and con?

In his favor are, first, the strong impression of sincerity which he gave, and the absence of a motive, which we have already mentioned; and, second, the judgment of the first investigating committee which had this point especially before it and which exonerated him of fraudulent intent. This by itself is not wholly convincing, perhaps, but it gathers force if we can show, on the one hand, that such movements may exist in full unconsciousness, in fact do so exist in the case of many people, and further that the course of training through which von Osten had put Hans was such as to offer opportunity for the cultivation of such movements and their unintentional growth into a system of signals such as was found to exist.

On the first point we have experimental evidence from Dr. Pfungst. As a portion of his study of the case Pfungst repeated in the psychological laboratory, as nearly as he could duplicate them, the experiments made with the horse in the court-yard. He himself took the rôle of Hans, tapping with his hand and watching for signals from the person who acted as questioner. He tried in this way some 25 people of different age, sex, and nationality, and he found but two persons in all who did not make unconscious movements of some sort by which he could tell when he had reached the numbers of which they were thinking intently, and one at least of these stolid ones was also wholly unable to get answers from Hans. Pfungst could even tell in some cases how simple problems in addition had been formulated,—whether, for example, the questioner had thought of $5 + 5 + 2$ or $2 + 5 + 5$. And his mistakes, which were not infrequent at first, were of the very same character as those made by Hans. Similar unconscious

movements were observed when directions were thought of—up, down, right, and left—and when particular objects were designated after the manner of Hans's row of colored cloths. It has been shown also by others (Lehmann and Hansen) that many persons in thinking of numbers whisper them unconsciously but in a way that can be heard at a distance by a proper adjustment of sound reflectors.

Unconscious movements are in all probability extremely common—the normal and regular thing, in fact—especially under conditions of considerable concentration, when (from the very fact of concentration on something else) their unconsciousness is doubly guaranteed. There is therefore no reason for thinking it strange that von Osten should make unconscious movements or that he was a fraud because he did not admit it but was caught in the act by Pfungst and others who watched him. He simply did not know the movements existed; and Pfungst here comes to his aid again with the observation that he himself found the movements easier to detect objectively in others than subjectively in himself, although he knew, of course, at the time that he was making such movements.

That such unconscious movements once present could grow up into a habit on the part of the master and into a set of signals for the horse is not hard to understand when we think of the process of training through which the horse was put. The old man stooped over anxiously to see that the horse tapped as he should—indeed, in the earlier stages of the training, the master with his hand assisted the horse in executing the proper number of taps—and then straightened up the least little bit, taking an attitude of a little less effort, when the required number had been reached. This sort of thing had gone on hour after hour and day after day for something like four years. There is room here and to spare for the forming of unconscious habits on one side and the perfecting of training on the other.

After the publication in the end of 1904 of an abstract of Pfungst's work with its annihilating assault on von Osten's conception of Hans' mentality the case seemed closed. The newspapers commented briefly on its outcome, and the general public turned to other matters, while the old man forbade further study of the horse by outsiders and doggedly took up again his patient teaching of him, working him out, as he believed, of the habit of responding to signals, into which the scientific experimenters had stupidly trained him. Thus ends the first chapter of the story.

The second chapter opens with the entrance of a new figure, Herr Karl Krall, a wealthy jeweler of Elberfeld. Krall had followed the Hans discussion in the newspapers and was one of the few who had remained unconvinced by the results of the Pfungst studies. About the middle of 1905 he visited von Osten and gradually prevailed upon the dour and crotchety old man to permit and even to co-operate in new experiments. These were continued at intervals up to 1908 and confirmed Krall's belief that Pfungst was wrong and von Osten right—that the horse actually did his own thinking. Later Krall purchased other horses for experiments on his own account, especially two Arabian stallions whose attainments under his teaching soon far surpassed those of Hans at his best. And finally he published last year a handsomely illustrated volume summarizing his work both with Hans and his own horses and the inferences which were to be drawn from the results which he obtained, and thus reopened the whole controversy.⁴

Let us see first what Krall got from his experiments with Hans. Early in his studies he undertook a repetition of the experiments made by Pfungst to determine whether the horse was able to answer questions when he could not see his questioner—the experiment with the blinders. Pfungst appears to have worked with large blinders on both sides of the horse's head. Krall worked with a single large blinder on one side, arranged, as he assures us, so as to correspond "in every way to the most rigid critical requirements." In the picture given to illustrate this outfit the blinder is re-enforced by a large piece of opaque cloth which covers the rear half of the blinder and most of the horse's head. In the execution of the experiments the questioner and his assistants stood at a distance of six or eight meters from the horse on the blindered side, to meet Pfungst's finding that at distances less than four and a half meters the control of the questioner when visible was still in some degree effective.

After a time sufficient, as Krall thought, to accustom the horse to the unfamiliar and bothersome limiting of his usual field of vision and to the new conditions Hans worked as well with the blinder on and with the questioner at a distance as in the more usual conditions. It was the same when experiments were made with the blinders on and at night. The horse apparently could work without sight of questioner.⁵

⁴ Krall: *Denkende Tiere*, Leipzig, 1912, pp. 532.

⁵ We must note, however, that in Pfungst's experiments the alleged unfamiliarity of the blinders did not distract Hans to such an extent as to hinder his attention to Pfungst or his answering nearly

These were by no means the only matters upon which Krall tested Hans in the five months or more scattered through several years during which he worked with him. He instituted regular tests of his keenness of vision, his discrimination of colors and forms, his liability to optical illusions, his senses of hearing, smell, taste, and touch, his speed of comprehension and his span of attention,—carrying out all these tests in the general manner in which they are made on human subjects. He even experimented upon Hans' powers of appreciation of the beautiful and ugly, and his consciousness of self. And through it all he had not infrequent, though undesired, occasion for observing the horse's willfulness, stubbornness and contrariness, features of horse psychology upon which in his later discussions he lays no small stress. Into all this, however, we have no time now to enter; nor do these experiments and observations, except perhaps those with reference to the horse's crankiness, touch the main question. If the horse has the independent mental endowment which von Osten and Krall believe he has, it is not surprising that such tests should have been possible; if the horse is guided, visually or otherwise, by some human being within sensory range, as Pfungst and others believe, there is no reason for surprise at any results within the limits of human capacity. What still remain the chief questions are the two upon which Pfungst worked: Can the horse think for himself, and if not, by what means does he draw upon his human environment? It is these two questions also that we shall keep uppermost in mind in our account of Krall's work with his own horses, Muhamed and Zarif.

But before we take up the training and feats of these horses, let us turn for a moment to their master. What manner of man is Krall? To this question we reply, depending here chiefly upon the statements of his partizan, Dr. William Mackenzie, that Krall is a respected member of a commercial family of wealth and importance in Elberfeld, still in busi-

all Pfungst's questions correctly when Hans could see him, and that in Krall's experiments in the dark there was some of the time light enough to distinguish objects as small as unlighted matches and to make it interesting for spectators in the tenement windows about, that in other experiments a lighted candle was used in the experiments themselves and in still others small light disks or transparencies—sources of light of possible consequence in case of an animal with as good night-vision as a horse. Under the circumstances the question naturally suggests itself whether the time supposed by Krall to have been necessary for accustoming the horse to the unfamiliar blinders was not in reality necessary for the establishment of a new sort of unconscious sensory guidance in place of that cut off by them.

ness and following science as an avocation. He is regarded by his neighbors as perhaps a trifle visionary, but of unquestioned good faith. Temperamentally he is open, enthusiastic, liable to say things of which his opponents can take advantage; he is inventive, full of the spirit of research, of a philosophic habit of mind, with something like a touch of genius. Before he became interested in Hans he had long devoted himself to psychological experimentation, but without publishing his results. In his house he has a considerable physical laboratory. His library is that of a student and especially strong in psychology.

His general standpoint in animal psychology is indicated by his contention that animal and human minds are of identical nature and that neither has come into being through evolution. The great bar to the recognition of this identity has been the absence of adequate means of communication between men and animals. It is von Osten's glory that he discovered a way by which this bar could be removed. Krall's own function has been to save von Osten's great discovery from oblivion (impending on account of the blunders of Pfungst and the bigotry of science), and to set it upon a firm basis of demonstration, paving the way to a complete mutual understanding between men and animals, with infinite possibilities of advantage to the animals because the concession of likeness in mentality necessarily involves also the concession of personality and a new set of ethical obligations on the part of man toward his fellow creatures. Krall mentions incidentally his affectionate interest in animals from his youth and his gratification that destiny has assigned to him the demonstration of their possession of reason and the general unity of Nature in the things of the mind. This attitude toward his own work and that of von Osten goes far to explain certain characteristics of his work in general and of the book which he has written.

In beginning the training of his own horses Krall introduced several minor improvements in method. He provided a special inclined platform on which the horse might work more easily and tap off his replies more distinctly; he altered the system of tapping, so that units were tapped with the right foot, tens with the left, and hundreds again with the right, thus improving the tapped replies both in speed and accuracy. When it came to reading and spelling he introduced a new and better letter table. He carried out the training also in such a way as to make the work as little fatiguing

to his pupils as possible. He did not, on the other hand, dispense wholly with the whip as von Osten had done.

For these or for other reasons the horses made phenomenal progress. After two weeks' training they executed simple commands and Muhamed had begun to show his arithmetical ability; he knew the numbers to ten and had caught the ideas of addition, subtraction and multiplication. During the first month the horses learned to perform commands given in German and in foreign tongues, both spoken and written, including Greek. After five months of training they had reached the mental level at which Hans had arrived at the end of four years. They surpassed him even then in the independence of their expression, and as their training continued soon surpassed him in all particulars.⁶

Of the attainments of Muhamed and Zarif I can give but a few samples, and I select, of course, striking instances, omitting the multitude of similar but less remarkable cases; I shall also confine myself to the results with arithmetical problems and in the use of language, neglecting many other lines of education from which hardly less astonishing results are reported,—as, for example, in the miscellaneous notes (pp.

⁶ An interesting item as to the manner of training and one that is not without possible significance for the method of the later work of the horses comes to us from the Düsseldorf veterinarian, Dr. Karl Wigge, from whom the following observation is cited by Ettlinger (*Der Streit um die rechnenden Pferde*, pp. 45 ff.):

"Wigge was able in the case of Berto [a blind stallion], who was led by the bridle, to assure himself that the blind stallion 'regularly began to tap at once with the right foot when Albert, the groom, after Krall had put the question, let loose the bridle, which he had before held taut.' In the same way Wigge reports with reference to another horse, Demir (able to see but blinded), that in his case also Albert held the bridle and gave signals with it. The question was the simple arithmetical problem $3 + 3$. 'So soon as the horse had tapped with the right foot up to 6, . . . Albert gave the bridle a little jerk and the tapping promptly ended. In case of numbers above ten, which have now passed from my mind, the jerk for the units was given with the right rein, for the tens with the left. Of especial interest in this connection was the question: How does one make zero? Albert pinched the horse in the right flank (turning of the horse's head to the right), then in the left flank (turning of the head to the left) and the zero was finished. No one of the spectators, so far as I could judge, had seen anything in this process, and Krall himself neither at that time nor in his book has given the least intimation of anything of the sort. The spectators were promptly charmed with the success of the pupil and clapped in lively approbation.'" (Wigge: *Deutsche tierärztliche Wochenschrift*, Dec 7, 1912.) The use of these means of control is not denied by Kralls partizans, but they explain that such means are used only in the early stages of the training and later become unnecessary.

490 ff. of Krall's book) which recount cases in which Muhamed dictated problems, drew inferences as to the identity of snow and rain, guessed simple riddles, recognized verbs, found rhymes for words given, and distinguished the concepts of beauty and ugliness.

Most of our instances will also be taken from the doings of this same Muhamed who is the brightest of Krall's stud and especially strong in the extraction of roots. Krall himself reports the solution of such examples as the following, the examples being written on the blackboard (pp. 119 f.):

$$\sqrt{64} \times \sqrt[3]{64} \text{ first answered wrong as } 42; \text{ then right as } 32.$$

$$\frac{\sqrt{36} \times \sqrt{64}}{50-2} \text{ answered with emphasis as } 1.$$

Visitors writing since the publication of Krall's book report Muhamed as solving (by head work alone, of course) problems like the following: $\sqrt[4]{614656}$ or $\sqrt[6]{147,008,443}$, though sometimes after a lengthy series of blunders. Krall had, however, at the time of his own writing, already introduced Muhamed to algebra and had obtained correct solutions of equations like the following:

$$\begin{aligned} x - 48 &= 46 & \sqrt{49} + x &= 16 \\ x \cdot 4 &= 128 & \sqrt{x} + 12 &= 18 \end{aligned}$$

The results in language include the reading of written words and letters (*i.e.*, the translating of them into an arbitrary system of taps with the foot), the phonetic spelling of spoken words, the recognition and naming of objects shown in pictures, the answering of spoken questions, and finally a certain amount of spontaneous expression in simple phrases and sentences. After some practice in the formation of sentences the words "was Zucker" were written on the blackboard. Muhamed tapped *süs*. Told that this was no sentence he tapped *z* [for *Zucker*] *ist*. "Was kannst du noch vom Zucker sagen?" *z ist weis*. "Und was noch? Ueberlege mal!" *z schmkt* [for *schmeckt*] *gut*. Asked next day for still another quality he tapped: *z ht 4 ek* [*Zucker hat vier Ecken*]. While note was being made of this Muhamed tapped spontaneously *iohn*. Johann asked: Was soll ich? M. replied *m gbn* [*Möhren geben*] and later, on similar occasions, filled the pauses with remarks of the same sort: *pao b gbn* [*Pao give bread*],* *iohn hfr gben* [*Johann give oats*].

* Pao is the horses name for Dr. Schoeller, for a good while Krall's trusted assistant.

ig m hbn [I to have carrots], *ig z haben* [I to have sugar], (pp. 157f).

Dr. Schoeller reports the following conversation with Muhamed after certain experiments in which Zarif had been intractable. I translate the paragraph, as an indication of the Elberfeld procedure in the investigation of the more complicated phenomena reported, not attempting, however, to reproduce the horse's peculiar orthography. The horse's replies are printed in italics. Dr. Schoeller writes:

"30 Jan., 1911. I ask Muhamed: Why was not Zarif good? M. *because is lazy*. I write on the blackboard: Why Zarif lazy? M. *because he said begin will not know*. As I do not understand what 'begin' means, I rub out all beyond *said* and ask again: M. *begin will not know anything of it*. M. is asked a third time and answers: *begin he will not know*. He persists with 'begin' and I assume now that he means perhaps 'at the beginning of the teaching.' I say nothing, but write on the board: why begin will Zarif not know? M. *because he is lazy*. Then I write, without speaking: how shall we make Zarif good? M. *be good*. I give it up now thinking that he does not understand me. Next evening (31 Jan., '11) I ask Muhamed, since Zarif that morning was again intractable: Why was not Zarif good this morning? M. *because Zarif ugghusra*. Though I do not understand the last word at once, I use it nevertheless and write: Why Zarif ugghusra? M. *because he is stubborn*. Then I say: I do not understand what ugghusra means, tell me it again. M. *unghorsam* (disobedient). Now I write on the board: why Zarif stubborn? M. *because he said no he will not*. I make a great effort to learn from him now what may be done in order to make Zarif tractable again. Muhamed perhaps did not understand me for he answered finally, as yesterday: *be good*. The meaning of this repeated answer is not clear to me since "goodness" on our part has never been lacking. The occasion of the failure to comprehend I came later to believe lay in the form of the question: What shall we do *in order to*, and therefore on the next day (1 Feb., '11) I try to teach the horse the connection between cause and effect. I did not light the light at first and said: One can't see well, how is it? M. *dark*. How ought it to be? M. *light*. After lighting up I write: What do we do in order to make it light? M. *light up*. I take now a picture book, which the horses have often seen, and in which the picture of a bright colored cock gives them particular pleasure as they have given us to understand in different ways. I write

on the board: What do we do in order to see cock? M. *open book*. Now I write: Zarif not good, what do we do in order Zarif good? M. *blow have*. I will not venture to decide whether he means by this reply instead of the earlier *be good* to show us the proper way of treating Zarif. It made quite the impression, however, that he had this time gotten the meaning of the question."

It is interesting to learn as we do from another source that Dr. Schoeller has for some time ceased to participate in the experiments and that Krall's statement as to his withdrawal is that Muhamed and Zarif have explained that Dr. Schoeller has become unsympathetic toward them and that they will no longer work with him.

Does this sound like a fairy tale? If so let us leave Krall for a moment and hear the testimony of a psychologist of international standing, Professor Edward Claparède, of the University of Geneva, who after seeing the horses with his own eyes reports his observations in the volume of the *Archives de Psychologie* for last year.

Again I cull an instance here and there. In the afternoon of the first day Muhamed was asked to spell the name of Claparède. He tapped off in his system of phonetic spelling *Klapard*. "But something is lacking," said Krall and Muhamed gave the letter *e*. Later the horse was asked to spell the name of another participant in the seance, Mr. Tauski. The name was repeated to him twice and he spelled *Tausj*. "One letter is lacking—what is it?" asked Krall. *c* tapped the horse. "No it is a *k*. At what place is it?" Muhamed tapped *4*, *au* counting as a single letter in the letter table in use. "And what letter comes after *k*?" The horse gives *i*.

The cube root of 5832 was given correctly in a few seconds. The square root of 15376 (= 124) and fourth root of 456976 (= 26) were given correctly in about ten seconds. In these tests Krall and the hostler had gone out of the room after the example had been written on the blackboard. The other participants were ignorant of the proper answers. Claparède notes, however, that at the same time Krall was unable to make Muhamed understand that he (Claparède) had a carrot for him and that Muhamed ought to go to him for it. With Claparède alone in the room and proposing a simple example like $15 + 7$ Muhamed answered wrong and indistinctly.

On the afternoon of the second day Claparède saw the horses alone with Krall, except for one of the grooms who was moving about in the stables near by but was not present at the seance itself. Muhamed was not in good form, gave

many false and meaningless answers but did a little work with square roots. In one instance he persisted in giving the answer 746 which was wrong, but gave immediately the correct one 747 after a cut with the whip. Zarif responded better especially in spelling, giving a recognizable approximation to Claparède's name and bettering it on cross questioning. Claparède asked Krall to give Zarif a bit of sugar and ask him to name it. Krall, however, thought to get at the name indirectly and said to him, Was wünschst du? [What would you like?] to which Zarif responded *Müdseinjg* [*miide sein ich, I am tired*]. Following up the questioning Krall asked, Wie heisst du? [What is your name?]. The horse replied *Garif*, using *g* which is No. 33 in the letter table for *z* which is No. 53. "What other letter," asked Krall still behind the door, "could you set in place of *f*?" *V* replied the horse. "Qui est Zarif?" asked Krall in French. *iig* [*ich*] replied the horse.

Professor Claparède risks, though with some reserve, an explicit statement that in his judgment correct responses were given by the horses under conditions that exclude absolutely the possibility of guidance by voluntary or involuntary signals, and that it seemed certain to him that the horses counted the taps and spelled spontaneously. For others, however, the growing pitch of the marvels has at last overstrained belief—to mention but one great name, Edinger the neurologist—and Claparède himself points out the need of experiments which lead to certainty and not merely to conviction. At a second visit during the present year Claparède attempted to make tests "without knowledge" upon several of the horses, but obtained only negative results, the experiments both "with knowledge" and "without knowledge" showing a similar and very large percentage of errors. *Archives de psychologie*, XIII, 1913, 244-284.

Since this is the case let us return to simpler and more fundamental matters. Let us see what evidence Krall has to offer in rebuttal of Pfungst's generally accepted demonstration of the dependence of Hans on unintended visual signals? Pfungst's argument is made in two stages. He sets out to prove first by means of tests with questions whose answers are unknown to the questioner (procedure "without knowledge") that Hans is not able to think on his own account, but depends in some way on his questioner; and with this established he then goes on to show by means of a variety of tests and experiments that Hans received guidance through seeing unconscious movements of his questioner.

Now it is clear that to refute Pfungst and to establish the case for independent thought on the part of the horse Krall must meet not only the second, but above all the first point of Pfungst's argument. For if he merely shows that there are cases in which visual cues are impossible, he overthrows, indeed, a portion of Pfungst's work, but fails to touch the fundamental point of the horse's dependence on his questioner. To prove the powers of the horse to be independent like those of man this dependence must be definitely disproved and on this point one would suppose that Krall would have trained his heaviest batteries. This he does not do. He busies himself rather with discrediting the hypothesis of guidance by visual signs, and to the piling up of new cases to be explained, but gives comparatively little space to tests "without knowledge," and treats even his own results with such tests in a very summary fashion, devoting but 13 of the more than 500 pages of his book to the special consideration of experiments of this sort and citing no detailed protocols.

In these 13 pages he argues that while right answers in experiments "without knowledge" would furnish positive proof of independent thought on the part of the horse, the failure of the horse to reply correctly or even at all in such cases does not prove that the horse cannot think independently, because the failure may be accounted for by the perversity of the horse, concurring thus with von Osten's explanation which was that when the horse discovers that his questioner is ignorant of the answer he loses respect for him, becomes intractable and answers wrong or not at all. The horse's surprising ability to discover whether the questioner knows or does not know the answer is credited to his very delicate responsiveness; "All horsemen know well," we are told, "how surely a fine horse shares his master's mood."

In the way of facts in support of this explanation Krall has these to offer as to the general "crankiness" of Hans. Even von Osten was not always successful with him. Most would-be questioners failed entirely, a few succeeded with the first question or two and thereafter failed. Hans refused also when the conditions were unusual, as when von Osten questioned with his back toward the horse; or he answered wrong to a stranger and right to his master.

In the matter of particular tests executed "without knowledge," the following are cited: First, certain tests carried out by Dr. Grabow in 1904 and reported at length by him to Krall (though whether these were reported from memory or from a full protocol taken at the time is not stated). In

these experiments Grabow stood in one corner of the court-yard, von Osten in another. The questions (simple arithmetical problems) were written on cards and shuffled by Grabow in his pocket. One of the cards was then drawn out at random and held up before Hans without being looked at by Grabow. The horse was then asked whether he had understood the problem, and on his signifying that he had, he was sent to his master who asked for the result and for the numbers entering into the problem. Then finally Grabow examined the card and verified the correctness of the response. Such tests were made on several days and are reported to have been with few exceptions successful; which, however, throws some doubt upon the rigidity of the conditions under which they were carried out, for similar experiments even with Krall were very far from generally successful.

Some of Krall's own experiments were made with more elaborate apparatus and in such a way as to dispense with the assistant. Hans usually answered the first two or three questions correctly and then refused. They probably were not made in great number, however, as such experiments met with opposition from von Osten who disliked to risk habituating the horse in refusing. In a very few cases Hans answered correctly and persisted in his answers when his questioner thought him in error, *e.g.*, in a series in which the cards shown were intended to contain only directions for certain movements to be made, Hans unexpectedly tapped the number 3 and held to it. Examination showed that a card carrying the word "*drei*" had been included by accident. In another case when the experiment was made by two persons, each showing Hans a card carrying a number unknown to the other and Hans giving the sum, Krall's assistant set a zero on his card. Krall had written five on his and on hearing Hans tap five declared the answer wrong, forgetting, for the moment, the possibility of zero being used. In these experiments also it was usually in the first few trials that Hans was right, and, in general, experiments "without knowledge" were more successful when not given in continuous series but interspersed among tests of other sorts.

These experiments and others like them seem to Krall to establish the ability of Hans to solve problems of which the answers are unknown to the questioner, but he finds still clearer evidence for independent thought in the peculiar and erratic spelling of his own horses, arguing that, as no one can foresee the particular one of several ways which they will use on any given occasion, each case of their spelling

becomes in fact an experiment "without knowledge." These horses could express negation by shaking the head, by moving it from side to side, by tapping off the word *nein*, either in full or in a variety of distortions and abbreviations, or by tapping simply *n* accompanied by the side to side movement of the head or by using the words *nicht* or *nichts*. Zarif for example had the following variety: *nein, ne-in, nien, nen, nieein, nicht, nig, nigd, nigts, nihjs, nigst, nych, nycht, neigt, ngeit* (p. 165). Similar variability is found also in the spelling of other words.

For Krall this possible variety in the means of expression constitutes proof positive that the horses do their own thinking, because the peculiar forms used are unpredictable. But is it after all so conclusive? Assume for a moment that the horses are intentionally controlled by a confederate; such a variety of response would then offer no difficulty. The particular forms of response would be equally unpredictable to all the company except the confederate. In a similar way if the control were unintentional and unconscious, the particular response would again be unpredictable and yet not independently selected by the horse. And when to this may be added a certain amount of pure blundering both on the part of the horse in following the control and of the controller in effecting it, there would seem to be room enough for all the variety of responses exhibited. And it will not do, of course, for Krall to say that such an explanation is inadmissible because there is no control of any sort, for that would be simply begging the question, the very point at issue being whether or not some form of control exists.

The experience with the horses which Krall next describes as a warning against hasty inferences from the failure of experiments "without knowledge" seems to the present writer one of the most important observations in the book and one which creates a strong presumption against the possession by the horses of anything like abstract numerical ideas. When Muhamed and Zarif were able to answer correctly problems in simple arithmetic written on the blackboard even when these involved eight or ten place numbers, they were found to give wholly erroneous answers to problems involving but two figures when these were presented on cards instead of on the customary blackboard, even when the cards were black and the figures made with chalk, and even when these black cards were held against the blackboard itself, though when the same figures were written directly on the blackboard all trouble disappeared. Krall's explanation is that by long habituation the

idea of number had become so firmly associated with the blackboard that figures not on the blackboard were not recognized as numbers. The breaking up of this supposed association, "required," he laments, "an incomparably greater expenditure of time and patience than to lead them [the horses] up to the number concept in general and to reckoning with ten-place numbers." But is it conceivable that creatures with such small powers of dissociation (since dissociation is an essential factor in the formation of abstract conceptions) could ever have grasped the abstract relation of the number system? And does not rather the failure of the horses to recognize numbers under these conditions throw doubt on the reality of their supposedly independent calculations in more familiar circumstances?

One more set of experiments "without knowledge" was carried out by Krall and his assistant, but in a manner so uncritical that to adduce it in a serious argument serves chiefly to throw doubt upon their whole course of experimentation. The experiment consisted in speaking to the horse from a distance by telephone (the assistant holding the receiver to the horse's ear) and requiring the horse to tap off what had been said to him, the experimenters assuming apparently that it was not possible for the assistant also to hear the rhythm and cadence of what was said and thus to receive at least a suggestion of the words used!

With this telephone experiment the chapter on experiments "without knowledge" comes to an end, and does so, in the present writer's opinion, distinctly without the presentation of sufficient evidence to establish, against the methodical series of Pfungst, the essential fact of the mental independence of the horses. It is highly probable that in the case of Krall's horses as well as in that of Hans we have to do with some form of control.

In his dealings, however, with Pfungst's second contention, that the horses are controlled by unconscious movements serving as visual signals, Krall is much more successful. We have Claparède's testimony that the horses gave correct replies when no human being was near, when Krall and all other spectators had left them, and their tapping was watched through a small glazed hole in a stable door. In other instances also, if we have all the essential facts, the difficulties of an explanation on the basis of control through visual stimuli are very great.

What other sense may serve in the place of vision we do not know. Krall asserts that experiments of his own have

shown that signals through the ear were not operative in the case of Hans, but does not describe the experiments further. In the absence of details, the possibility of such signals can hardly be surrendered. It will also be recalled that Pfungst made no serious study of the possibilities of unconscious guidance in other ways than through vision. It is certainly premature to propose the alternative of independent thought on the part of the horses or an, as yet unknown "*Konnex*," such as thought-transference, or something of the kind, between the horse and the questioner, until the sense possibilities have been definitely exhausted; nor can the believer in such an hypothesis be brought to book by a demand that he show in advance how these other senses would operate, for that is something which only a special experimental study of the horses could be expected to discover. It is enough that such an hypothesis has not been explicitly disproved; and until it has been explicitly disproved, it must take precedence of that of independent thought on the part of the horses as well as that of "thought-transference."⁷ The very small number of fully established cases in which the horses seemed to persist in correct replies, against the belief of the questioner that they were mistaken, probably does not exceed the limits of chance successes.

And thus I am compelled to bring my tale of learned horses to a close without the final solution of the mystery, a dramatic blemish which I regret but am powerless to remove.

There remain, however, one or two general matters of which I should like to speak. First with reference to the minds of horses. To assert that Hans and the Elberfeld horses probably do not think in the human fashion in which von Osten and Krall have supposed them to think is by no means to deny that horses have minds or even to affirm that the minds which they possess are of a totally different stuff from those possessed by man. Most comparative psychologists would, I imagine, accept the hypothesis that the mind of man has come up in the process of evolution from an undeveloped original similar to that from which the minds of animals have come. But this is a very different matter from saying that

⁷ I do not consider the possibility of intentional guidance, though it is a possibility, for we have almost no data upon which to go. There seems to be general agreement as to the absolute good faith of Krall, but that he may have been played upon by unscrupulous grooms or others is a possibility which cannot be thrust aside on a mere impression that it is not so, but must in the end be definitely brought to the test and proved or disproved like any other hypothesis.

the minds of horses, which are now fitted to a horse body and a horse life and have back of them untold ages of horse development can by a few months' teaching be transformed into tolerable likeness to the mind of man which is associated with a human body, has been moulded to a human environment and has had a human evolutionary history. Every animal is equipped with a set of fundamental instincts suited to its manner of life, and adaptation in instinct is every whit as essential to physical survival as adaptation in bodily structure. These instincts are the original framework of the animal's mind, and by determining its attention determine the formation of its habits and its responses to all the moulding influences of its environment. That there is some plasticity in these instincts and so some chance for progress does not in the least invalidate the original adaptation of which we are speaking. We shall expect to find horse minds keen and active and showing their greatest feats in matters of importance to horse life, and they will be most capable of training in the same direction. The work of von Osten, Pfungst and Krall, even under the most conservative construction, shows a responsiveness in horses far more keen than had generally been suspected and is a first-class contribution to comparative psychology.

And yet the chief interest of these experiments in the present writer's judgment, lies in the closeness with which they correspond in their general features to the human experiences dealt with by the Society for Psychical Research. We have in both a group of very unusual phenomena obtainable by some observers and imperfectly or not at all by others, phenomena which we are asked to regard in one case as the sign of independent human thinking on the part of the horses and in the other as the evidence of supernatural powers in the medium, phenomena which in both cases very closely resemble results obtained by trainers and magicians through means avowedly deceptive. We have as the chief human actors men of good faith, but strong preconceptions like von Osten or of active and enthusiastic temperament like Krall, to whom the systematic and formal procedure of science has little attraction. We have the same unwillingness—not altogether unnatural—to permit exhaustive experiments by controversial opponents, because they are "unsympathetic to the horses" or because they are apt to destroy for a time or permanently the essential conditions of the phenomena. We have the same attempts to prove the case by testimony instead of by rigid experimentation, especially by the testimony of men of unimpeachable integrity and of distinction in other lines of study,

but of no experience whatever in the matters really at issue. The impression is not to be avoided that we are dealing here with real analogies and not superficial resemblances, and that perhaps the delicate responsiveness of horses and dogs offers us a means of bringing some of the mediumistic phenomena into the laboratory in manageable fashion. It may, at any rate, be safely conjectured that when the case of the horses has been followed through to the bitter end we shall know a good deal more than we do now about the finer and supposedly occult workings of the human psycho-physical machine.